Service Handbook

COMMERCIAL GAS WATER HEATERS

500 Tennessee Waltz Parkway
Ashland City, TN 37015

MODEL BTR 500/A SERIES 120/121

INSTALLATION CONSIDERATIONS - PRE SERVICE CHECKS - OPERATION & SERVICE -TROUBLESHOOTING

SERVICING SHOULD ONLY BE PERFORMED BY A QUALIFIED SERVICE AGENT.

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COMMERCIAL GAS WATER HEATER SERVICE MANUAL

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Servicing should only be performed by a Qualified Service Agent

INTRODUCTION

This Service Manual is designed to be an aid in servicing and troubleshooting A. O. Smith Master-Fit models BTR 500 Series 120/121 commercial water heaters. The instructions and illustrations contained in this service manual will provide you with troubleshooting procedures to verify proper operation and to diagnose and repair common service problems.

This Service Manual does not replace or supersede the instruction manual that came with the water heater. Always refer to the instruction manual that came with the water heater for complete installation instructions. If the instruction manual is not available, copies can be obtained from the manufacturer's web site or by calling the toll free phone number shown on the back cover of this service manual.

QUALIFICATIONS

Servicing the products referenced in this manual requires the ability (in the field involved) equivalent to that of a Qualified Service Agent as defined by the American National Standards Institute (ANSI) below. Installation skills such as plumbing, air supply, venting, gas supply, electrical supply are required in addition to diagnostic and electrical testing skills.

ANSI Z223.1 2006 Sec. 3.3.83: "Qualified Agency" - "Any individual, firm, corporation or company that either in person or through a representative is engaged in and is responsible for (a) the installation, testing or replacement of gas piping or (b) the connection, installation, testing, repair or servicing of appliances and equipment; that is experienced in such work; that is familiar with all precautions required; and that has complied with all the requirements of the authority having jurisdiction."

SERVICE WARNING

If you are not qualified (as defined by ANSI above) and licensed or certified as required by the authority having jurisdiction to perform a given task, do not attempt to perform any of the procedures described in this manual. If you do not understand the instructions given in this manual, do not attempt to perform any procedures outlined in this manual.

SERVICE REMINDER

When performing any troubleshooting step outlined in this service manual, always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to and from a given component before replacement. Ensure wires were stripped before being crimped in a wire connector, ensure wires are crimped tightly in their connectors, ensure connection pins in sockets and plugs are not damaged or worn, ensure plugs and sockets are mating properly and providing good contact.

Failure to perform this critical step or failing to perform this step thoroughly often results in needless down time, unnecessary parts replacement, and customer dissatisfaction.

REQUIREMENTS

INSTRUCTION MANUAL

Have a copy of the instruction manual that came with the water heater on hand for the model being serviced. Instruction manuals can be obtained at the A. O. Smith web site (www.hotwater.com) or by calling technical support at 800 527-1953.

Installation information given in this service manual is not a complete installation instruction. Installation information covered in this service manual has a limited focus as it applies to servicing the water heater. This Service Manual does not replace or supersede the instruction manual that came with the water heater. Always refer to the instruction manual that came with the water heater for complete installation instructions.

TOOLS REQUIRED

- Phillips head screwdriver
- standard screwdrivers
- 3/8 and 7/16 inch open end wrench
- set of marked drill bits
- electrical multimeter tester capable of measuring continuity, AC voltage, and DC voltage
- gas pressure gauge or manometer (gauge - AOS pt. no. 9005033105)
- water pressure gauge (AOS pt. no. 9004792105)
- thermometer (AOS pt no. 9005423105 - range 0 - 220 degrees F)
- 1/2 inch socket with extension for removal of the clean out cover
- 1-1/16 inch socket with extension for anode removal

TOOLS OPTIONAL

- Two digital manometers range -20.00 to +20.00” W.C., resolution 0.01” W.C. Recommend UEI model EM200, TPI model 620 or equivalent.

INSTALLATION CONSIDERATIONS

Installation information given in this service manual IS NOT a complete installation instruction. Installation information covered in this service manual has a limited focus as it applies to servicing. This service manual does not replace or supersede the Instruction Manual that came with the water heater. Always refer to the instruction manual that came with the water heater for complete installation instructions.

If the instruction manual that came with the water heater is not on hand, copies can be obtained from the manufacturer's web site or by calling the toll free phone number shown on the back cover of this service manual.

WATER PIPING

Closed Water Systems

Water supply systems may, because of code requirements or such conditions as high line pressure, among others, have installed devices such as pressure reducing valves, check valves, and back flow preventers. Devices such as these cause the water system to be a closed system.

Thermal Expansion

As water is heated, it expands (thermal expansion). In a closed system, the volume of water will grow when it is heated. As the volume of water grows, there will be a corresponding increase in water pressure due to thermal expansion. Thermal expansion can cause premature tank failure (leakage). This type of failure is not covered under the limited warranty. Thermal expansion can also cause intermittent temperature-pressure relief valve operation: water discharged from the valve due to excessive pressure build up. This condition is not covered under the limited warranty. The temperature-pressure relief valve is not intended for the constant relief of thermal expansion.

A properly sized thermal expansion tank should be installed on all closed systems to control the harmful effects of thermal expansion. Contact a local Qualified Service Agency (page 3) to have a thermal expansion tank installed.

GAS PRESSURE REQUIREMENTS

Table 1 shows supply and manifold gas pressure requirements for BTR 500/A 120 - 121 model water heaters. Supply gas pressure is the pressure of fuel gas being supplied to the water heater. Manifold gas pressure is the pressure of the gas being supplied to the water heater's burners.

Supply gas pressure should be measured twice. One measurement while the water heater is not firing (static) and again while the water heater is firing (dynamic). If the supply gas pressure drops more than 1.5" W.C. between the static and dynamic pressure measurements, this may indicate the gas line and/or gas regulator to the water heater is undersized. See the gas line requirements in the Instruction Manual that came with the water heater.

Table 1

	NATURAL GAS	PROPANE (LP) GAS
‡ Maximum Supply Gas Pressure	10” W.C. (2.49 kPa)	12” W.C. (2.99 kPa)
† Minimum Supply Gas Pressure	5.2” W.C. (1.29 kPa)	11” W.C. (2.74 kPa)
* Manifold Gas Pressure	3.5” W.C. (0.87 kPa)	10” W.C. (2.49 kPa)

‡ Maximum supply pressure; readings are taken while gas is not flowing (static pressure) AND while gas is flowing (dynamic pressure). Supply pressure must never exceed this maximum value.

† Minimum supply gas pressure; readings are taken while gas is not flowing (static pressure) AND while gas is flowing (dynamic pressure). Supply pressure must never fall below the minimum values. Supply gas pressures should be measured with all gas fired appliances conencted to a common main firing at full capacity. If supply pressure drops more than 1.5” W.C. as gas begins to flow, the supply gas system (gas line/regulator) may be restricted or undersized. See the instruction manual for more information.

* Manifold gas pressure; reading can only be taken while gas is flowing. Reading taken should be ± 0.3” W.C. of the listed value. These water heaters are certified for use without modification for altitudes up to 10,000 feet. For elevations above 10,000 feet (3,048 meters), see High Altitude Installations section of instruction manual.

AIR REQUIREMENTS

Carefully review the requirements for combustion and ventilation air in the instruction manual that came with the water heater. Failure to meet these requirements when the water heater is installed or overlooking their importance when servicing the water heater often results in operational problems (some are listed below), needless down time, unnecessary parts replacement, and customer dissatisfaction.

Ensure additional air for combustion and ventilation is provided when additional gas fired appliances are installed to increase hot water supply in an existing location.

Air Supply

Stoichiometric or theoretical complete combustion requires 10 cubic feet of air per 1,000 BTUH of gas supplied. The National Fuel Gas Code also recommends an additional 2.5 cubic feet of “excess” air. For information on minimum make-up air opening sizes for various building installations, refer to the National Fuel Gas Code NFPA 54, ANSI Z223.1.

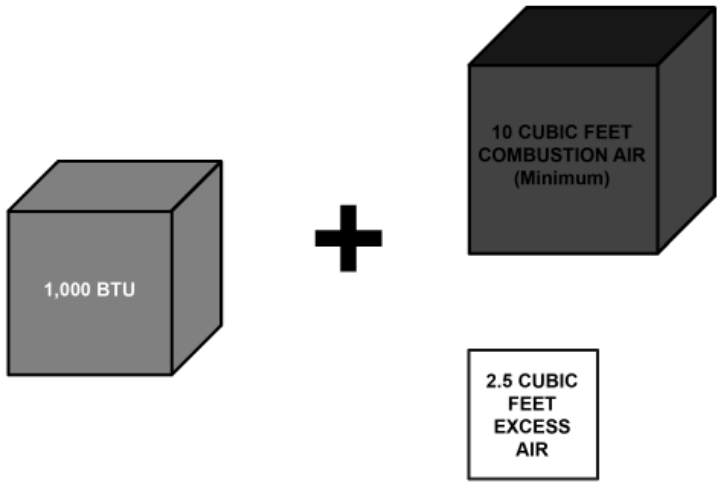


Figure 1

Insufficient Make-up Air, Negative Air Pressure, and Downdrafts

A lack of combustion and ventilation air can create a negative ambient air pressure in the installed space. The vent system on one or more gas fired appliances can experience down drafts due to the outdoor air pressure being greater than the ambient air pressure in the installed space. Where multiple gas fired appliances are installed, one or more gas fired appliances can “pull air” through the vent system(s) of other appliances installed nearby.

Downdraft Caused by Kitchen Vent Hood

Figure 2

One common example is in a restaurant installation where exhaust vent equipment was not considered in sizing make-up air requirements. This condition may result in air being back drafted by the restaurant exhaust equipment through the water heater, causing the draft proving switch to open and/or erratic heater shutdown. See Figure 2.

- Down drafts can cause poor mixing of fuel gas and combustion air in the burners.
- Down drafts can cause flue gases to spill into the installed space.
- Down drafts can cause common service problems such as ignition failure. Down drafts can sweep pilot gas away from the spark igniter during ignition and prevent ignition of the pilot.
- Down drafts may cause extremely dangerous conditions such as flame rollout where the flames from the main burner “roll out” of the combustion chamber.

Make-up Air: Direct Communication with Outdoors

A fresh supply of make-up air for combustion can be supplied to the water heater through make-up air ducts, which directly communicate with the outdoors. (Not Direct Vent.)

Two openings are required: one within 12 inches of the top of the enclosure and one within 12 inches of the bottom of the enclosure. Each opening must have a free area of not less than 1 square inch per 4,000 BTUH of the total input of all appliances within the enclosure. The lower opening primarily provides combustion air. The upper opening provides vent dilution air and acts as a relief opening for flue gases should the vent become obstructed or a downdraft condition occur.

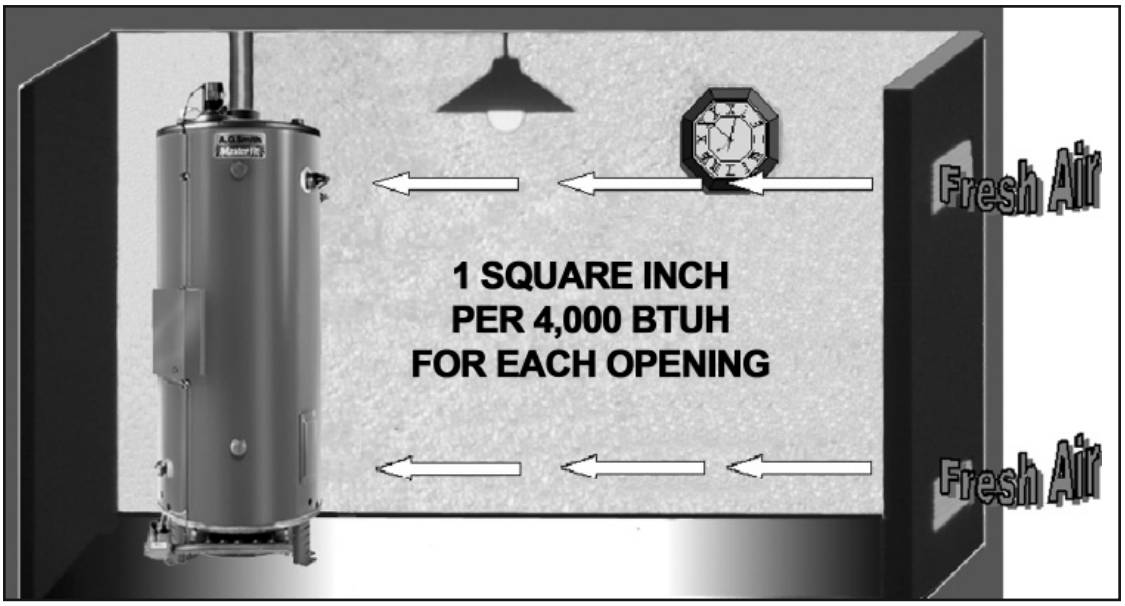


Figure 3

Additionally, when the water heater is installed in a confined space and communicating with the outdoor air, one permanent opening, beginning within 12 inches (30 cm) of the top of the enclosure, must be permitted where the equipment has clearances of at least 1 inch (2.5 cm) from the sides and back, and 6 inches (16 cm) from the front of the appliance. The opening must directly communicate with the outdoors and must communicate through a vertical or horizontal duct to the outdoors or spaces (crawl or attic) that freely communicate with the outdoors, and must have a minimum free area of a) 1 square inch per 3,000 BTUH ($7cm^2$ per kW) of the total input of all equipment located in the enclosure and b) not less than the sum of the areas of all vent connectors in the confined space.

Contaminated Air

Carefully review the warnings concerning contaminated combustion and ventilation air in the instruction manual that came with the water heater. Combustion air that is contaminated can greatly diminish the life span of the water heater and water heater components such as burners, igniters, flue baffles and vent system components. Propellants of aerosol sprays, beauty shop supplies, water softener chemicals and chemicals used in dry cleaning processes that are present in the combustion, ventilation or ambient air can cause such damage.

Vapors from volatile compounds such as solvents, cleaners, chlorine based chemicals and refrigerants in addition to being highly flammable in many cases, can also react to form highly corrosive substances such as hydrochloric acid inside the water heater's combustion chamber. The results can be hazardous and cause product failure.

Contaminated Air Causes Aggressive Corrosion of Water Heater Components
(Burners, Igniters, Flue Baffles, Vent System, Sheet Metal Parts)

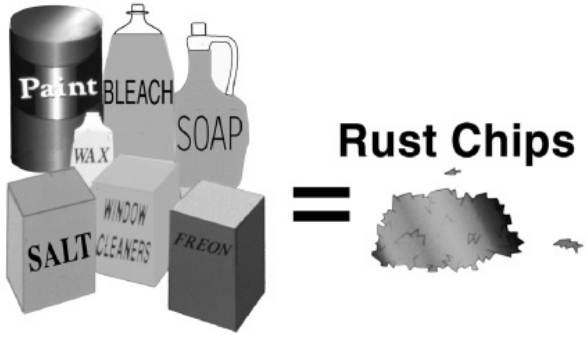


Figure 4

CLEARANCES (WATER HEATER)

A 24-inch clearance for all serviceable parts is recommended. See also Figure 5 and Table 2. You may also refer to the instruction manual or to the label on the water heater for clearances applicable to your specific model.

Minimum Clearances to Combustible Surfaces

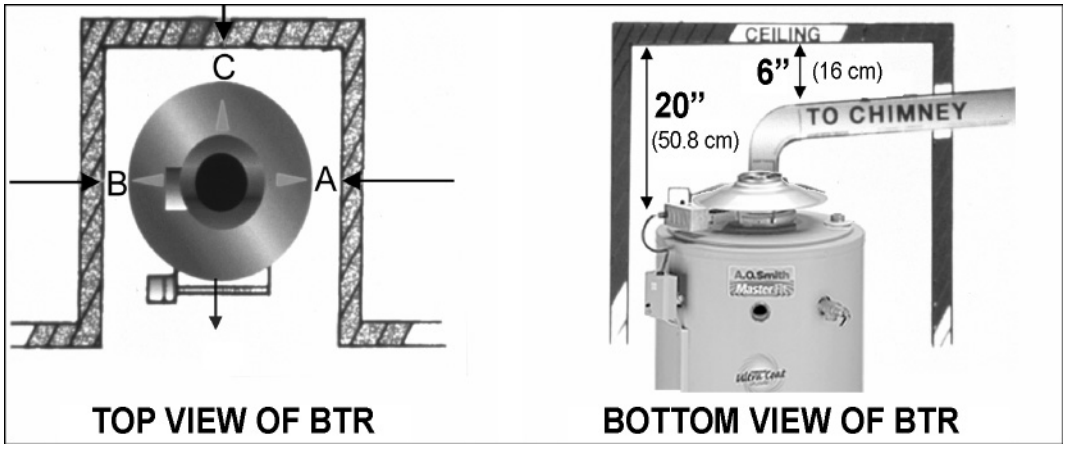


Figure 5

Table 2

MINIMUM CLEARANCES TO COMBUSTIBLE SURFACES		
“A” - Right Side	“B” - Left Side	“C” - Back
5” (12.7 cm)	5” (12.7 cm)	5” (12.7 cm)

A, B, and C clearances to non-combustible surfaces is “0” inches. A 20” clearance to cover remains unchanged.

CLEARANCES (EXTERIOR)

The illustration below shows the required clearances for venting units using natural draft venting. The vent must extend at least 3 feet above the highest point where it passes through a roof of a building and at least 2 feet higher than any portion of a building within a horizontal distance of 10 feet (for vents of 12 inches in diameter or less).

Reference: NFPA 54 ANSI Z 223.1.

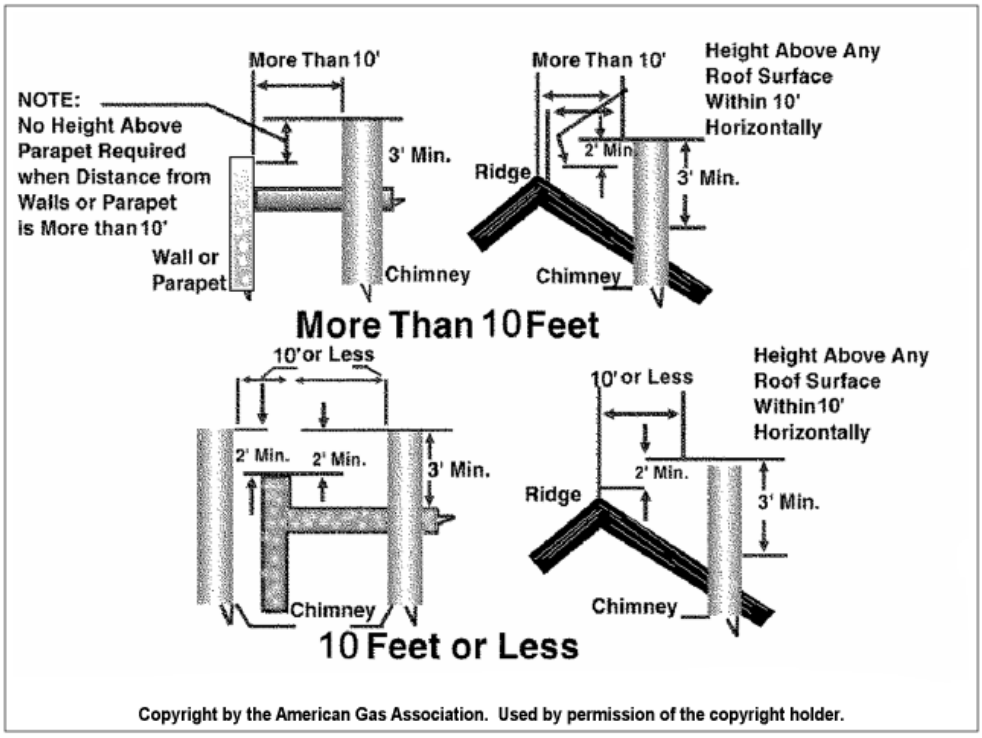


Figure 6

VENTING

The BTR 500 water heater is classified by ANSI as a Category I (non-condensing, negative pressure venting) appliance. It is approved for type B vent. The blower (draft inducer) does not pressurize the exhaust.

NOTE: This section of the service manual is not a complete venting installation instruction. Refer to the instruction manual that came with the water heater; ensure the venting has been installed per all instruction manual requirements. Installation must also conform with the current edition of the National Fuel Gas Code (NFPA 54/ANSI Z223.1). Costs to correct installation errors are not covered under the limited warranty.

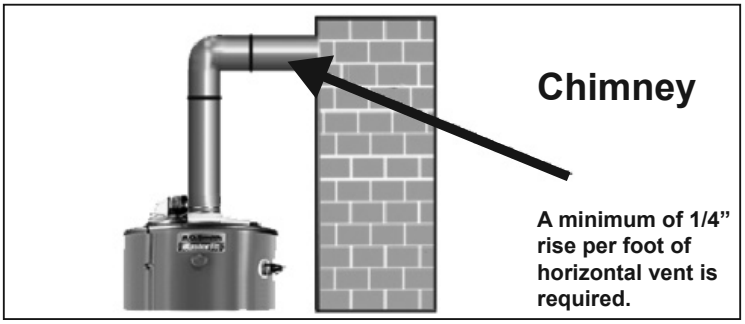


Figure 7

For larger applications, BTR 500 water heaters can be common vented together, either in a tapered manifold or a constant size manifold. See Figure 8. In such cases, follow the National Fuel Gas Code requirements for the sizing and installation of fan-assisted products. The BTR 500 model may be common vented only with other Category I appliances.

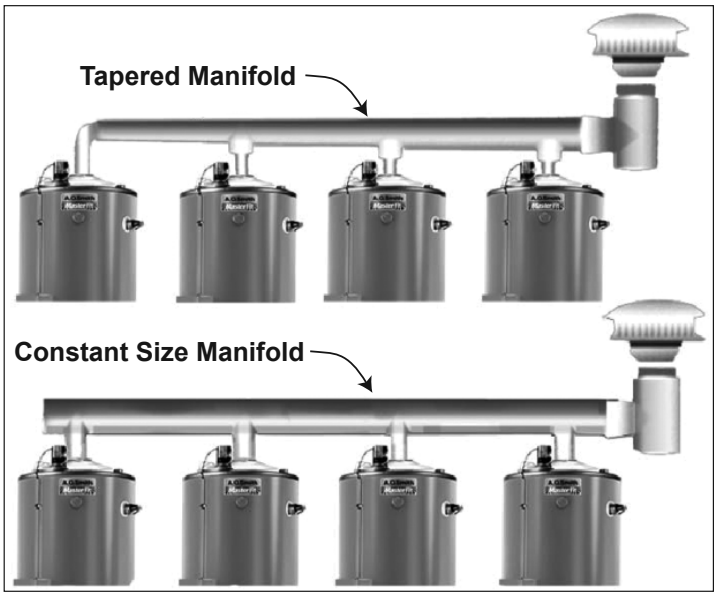


Figure 8

OPERATION AND SERVICE

SEQUENCE OF OPERATION

1. Call for heat is activated when temperature sensed from Thermistor Probes falls below the Thermostat setting.
2. Blower (Draft Inducer) is energized.
3. Ignition Control Board verifies that the Blower Prover Switch is closed and that the Blower (Draft Inducer) is operating.
4. Igniter is energized.
5. Gas Valve is energized and burners ignite
6. Ignition Control Board verifies flame at burners.
7. Water is heated to Thermostat set point.
8. Gas Valve is de-energized.
9. Blower runs for purge period and is de-energized.
10. Ignition Control Board goes into standby mode and Blower Prover Switch Opens.

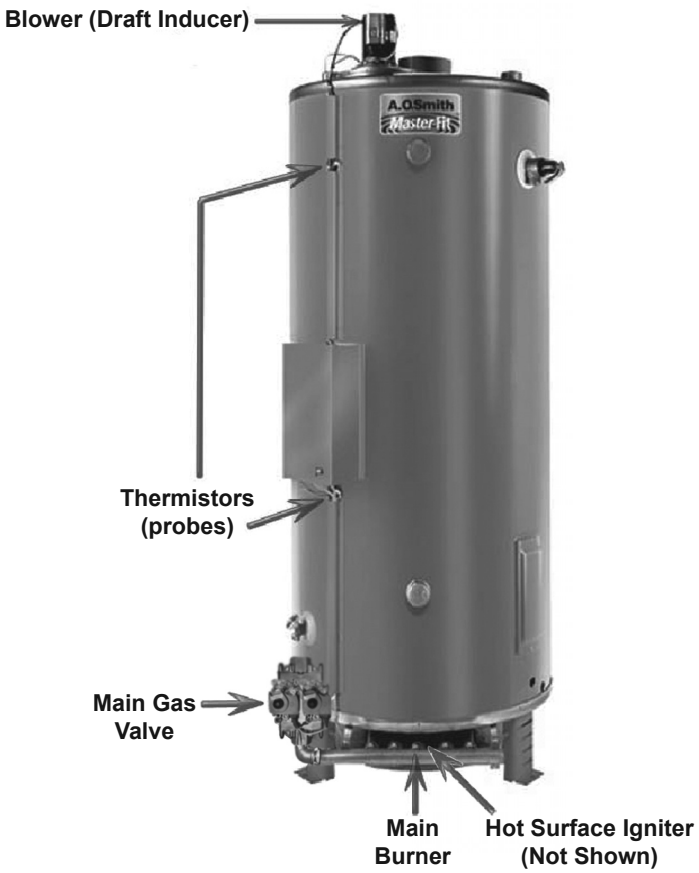


Figure 9

ELECTRICAL SEQUENCE

1. Switch Power on to unit.
2. Thermostat calls for heat.
3. Ignition Control Board performs diagnostic check on system components.
4. On completion of diagnostics check, the Ignition Control Board energizes the Blower (Draft Inducer).
5. The Blower (Draft Inducer) begins drawing air through appliance, closing the Blower Prover Switch.
6. On completion of Blower Prover Switch engagement, the Ignition Control Board begins the ignition cycle.
7. The Ignition Control Board provides power to the Silicon Nitride Igniter.
8. The Silicon Nitride Igniter heats up for approximately 17 to 20 seconds.
9. At the end of Silicon Nitride Igniter's warm-up, the Ignition Control Board opens the Gas Valve.
10. From the time the Gas Valve opens, the Ignition Control Board waits 3 seconds and then shuts off power to the Silicon Nitride Igniter.
11. From the time the Silicon Nitride Igniter's power is shut off, the Ignition Control Board waits 3 more seconds to monitor the Flame Sensor.
12. If the Ignition Control Board does not detect flame at the burners, it will de-energize the Gas Valve and run the Blower for approximately 20 seconds to purge the combustion chamber. The Ignition Control Board then restarts at Step 7 for up to 2 more trials for ignition. After the third failed trial for ignition, the Ignition Control Board locks out for one hour. At the end of this lock out period, the Ignition Control Board will restart at Step 3 for three more trials. NOTE: The one hour lock out period can be reset by cycling power to the water heater off and on again.
13. If the Ignition Control Board detects a strong flame from the Flame Sensor, it will remain in the heating mode until the Thermostat is satisfied.
14. When the Thermostat is satisfied, the Ignition Control Board will de-energize the Gas Valve and run the Draft Inducer for approximately 20 seconds to purge the combustion chamber. The Ignition Control Board will then go into standby mode.

WIRING DIAGRAM

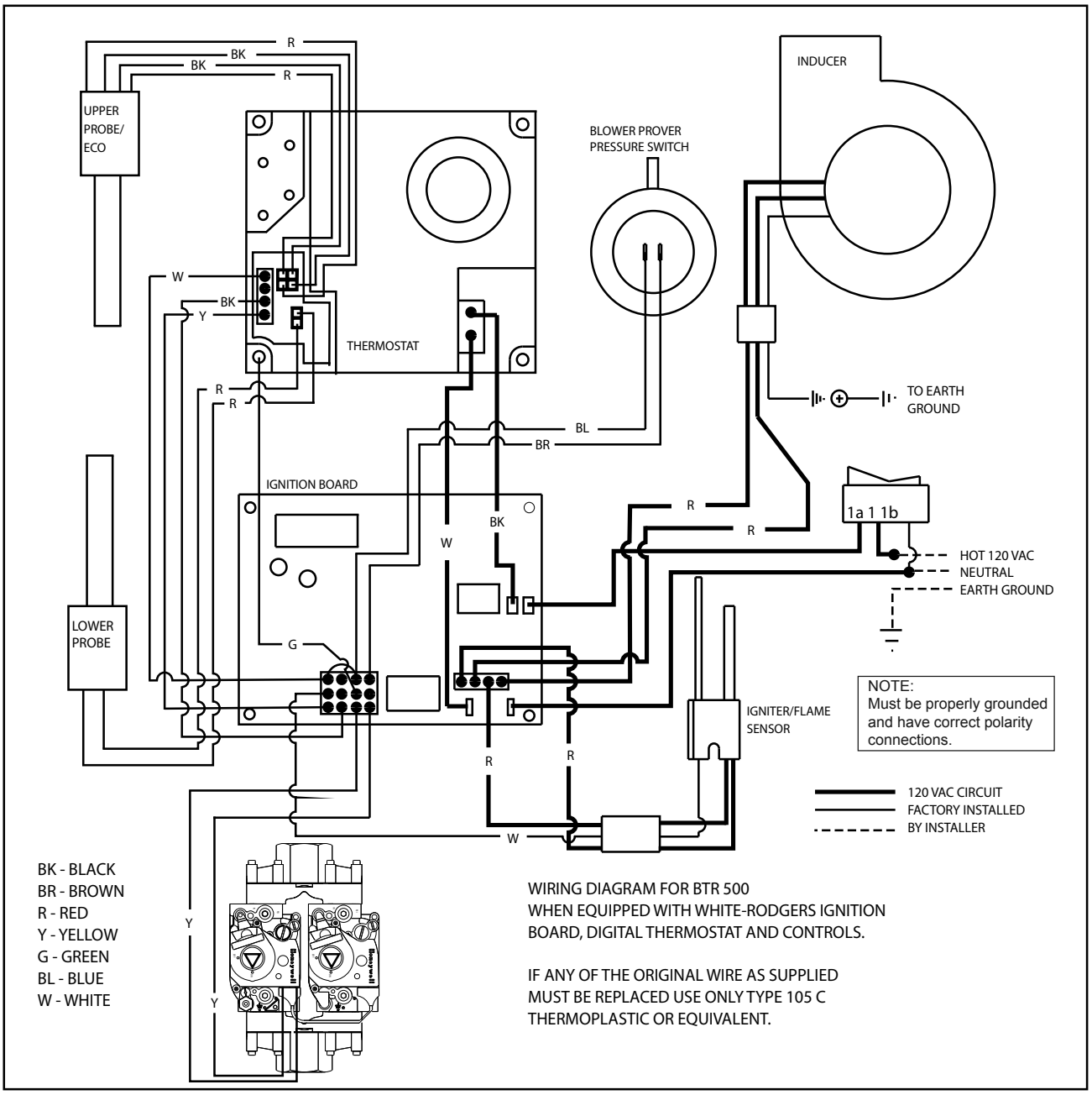


Figure 10

⚠ WARNING

Disconnect from electrical supply before servicing unit. Replace all doors and panels before operating the water heater.

OPERATING SEQUENCE - FLOW CHART

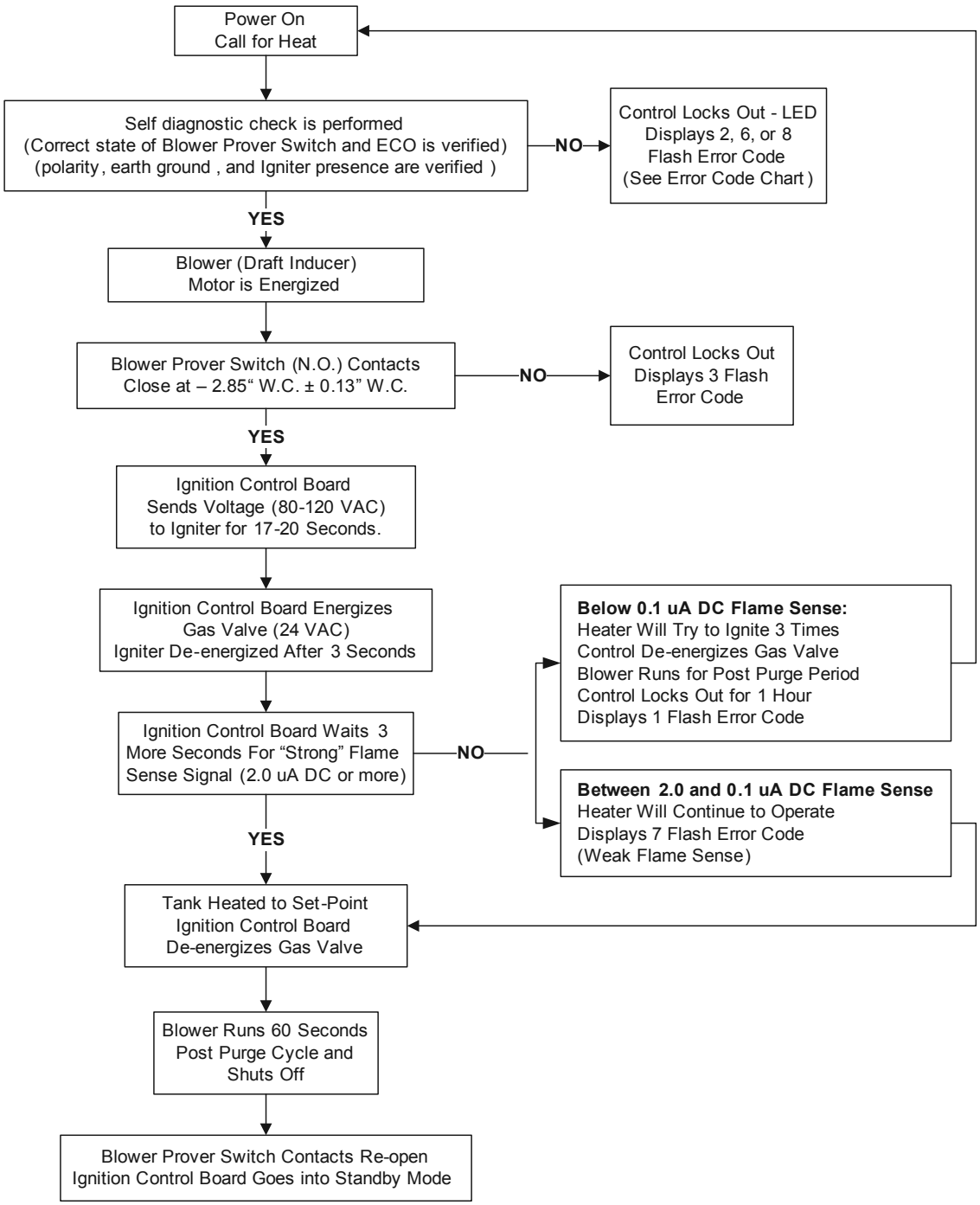

Power On
Call for Heat
Self diagnostic check is performed
(Correct state of Blower Prover Switch and ECO is verified)
(polarity, earth ground , and Igniter presence are verified)
NO
Control Locks Out - LED
Displays 2, 6, or 8
Flash Error Code
(See Error Code Chart)
YES
Blower (Draft Inducer)
Motor is Energized
Blower Prover Switch (N.O.) Contacts
Close at – 2.85“ W.C. ± 0.13” W.C.
NO
Control Locks Out
Displays 3 Flash
Error Code
YES
Ignition Control Board
Sends Voltage (80-120 VAC)
to Igniter for 17-20 Seconds.
Ignition Control Board Energizes
Gas Valve (24 VAC)
Igniter De-energized After 3 Seconds
Ignition Control Board Waits 3
More Seconds For “Strong” Flame
Sense Signal (2.0 uA DC or more)
NO
Below 0.1 uA DC Flame Sense:
Heater Will Try to Ignite 3 Times
Control De-energizes Gas Valve
Blower Runs for Post Purge Period
Control Locks Out for 1 Hour
Displays 1 Flash Error Code
Between 2.0 and 0.1 uA DC Flame Sense
Heater Will Continue to Operate
Displays 7 Flash Error Code
(Weak Flame Sense)
YES
Tank Heated to Set-Point
Ignition Control Board
De-energizes Gas Valve
Blower Runs 60 Seconds
Post Purge Cycle and
Shuts Off
Blower Prover Switch Contacts Re-open
Ignition Control Board Goes into Standby Mode

Figure 11

GAS CONTROL VALVE

This gas valve is a 24 volt AC combination-step opening valve. It includes two valves assembled in parallel, connected by a wiring harness. Note that the valves have fixed pressure regulation and are not adjustable. However, the manifold (outlet) pressure is adjustable as described on the next page.

IMPORTANT:

- For complete device shut-off, both gas control knobs must be in the OFF position.
- Both gas control knobs must be in the same position for operation or shutoff.
- Do not alter or remove the wiring harness.
- Do not apply a jumper across the valve lead wires or short them together.

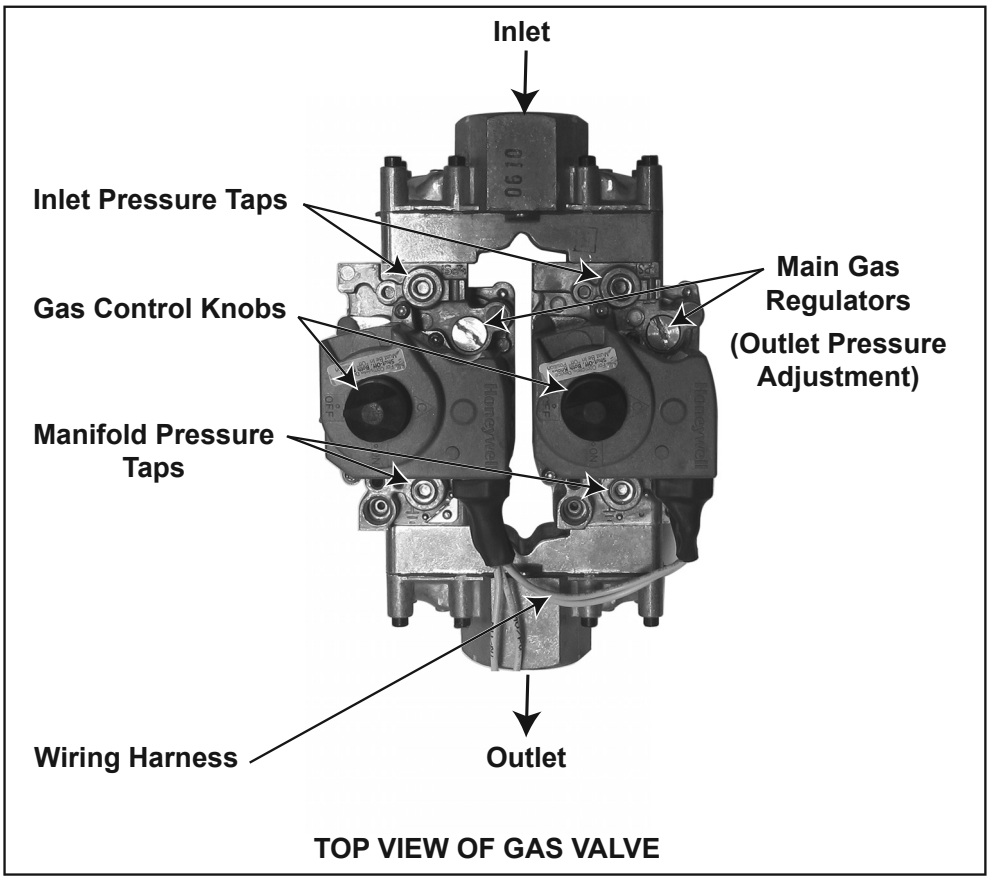


Figure 12

Measuring Gas Pressures

The supply gas pressure is measured at the inlet pressure tap when the gas is flowing. The manifold gas pressure is measured at the manifold pressure tap when the gas is flowing.

Manifold Pressure Adjustment

The main gas regulators are found beneath the silver or black cap screws. (Natural Gas valves have silver caps; Propane valves have a black caps). Remove the caps to access the outlet (manifold) pressure adjustment screw. IMPORTANT: Ensure that the outlet pressure matches the manifold pressure that is listed on the water heater rating plate.

- Natural Gas valves are factory preset to 3.5 inches W.C. The full rate outlet pressure range is between 3 and 5 inches W.C.
- Propane (LP) valves are factory preset to 10.0 inches W.C. The full rate outlet pressure range is between 8 and 12 inches W.C.
- Caution: Always test the manifold pressure at the outlet when the gas is flowing.

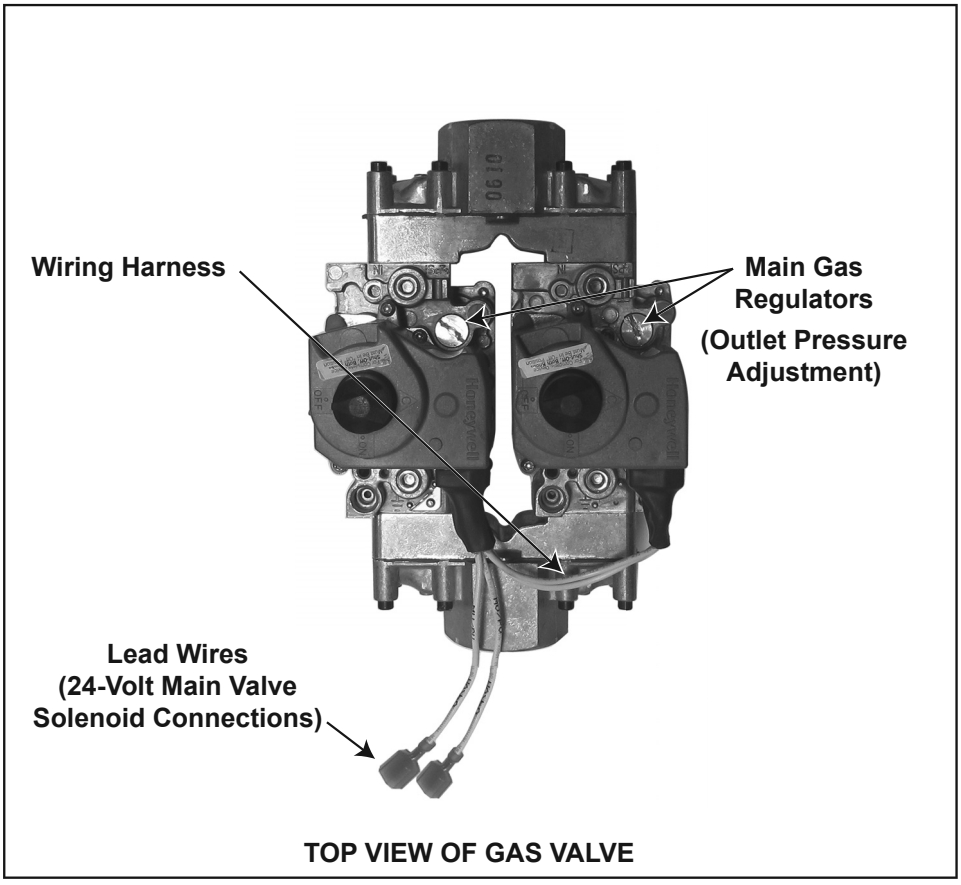

Wiring Harness
Main Gas Regulators
(Outlet Pressure Adjustment)
Lead Wires (24-Volt Main Valve Solenoid Connections)
TOP VIEW OF GAS VALVE

Figure 13

Main Valve Solenoid Connections

The figure above shows the two 24-volt main valve (MV) solenoid connections. The two yellow wires from the 12-pin ignition board plug connect to these leads.

GAS CONTROL VALVE/BURNER AREA VIEW

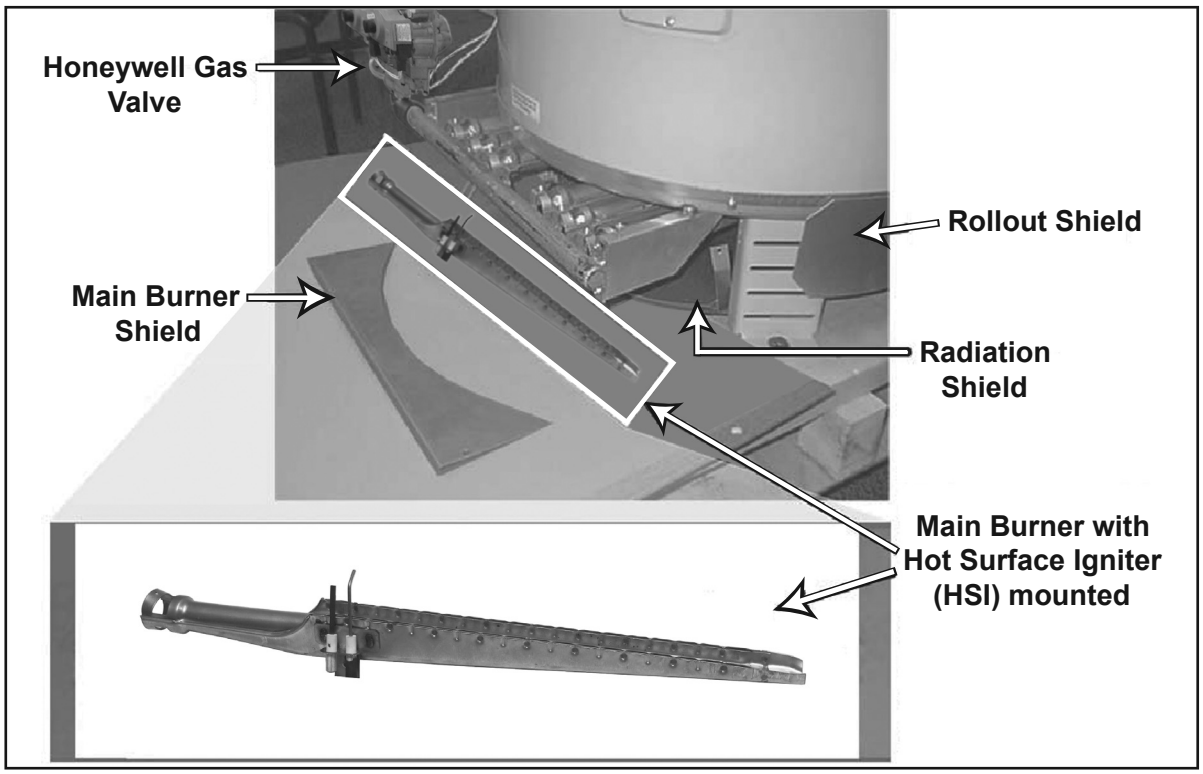
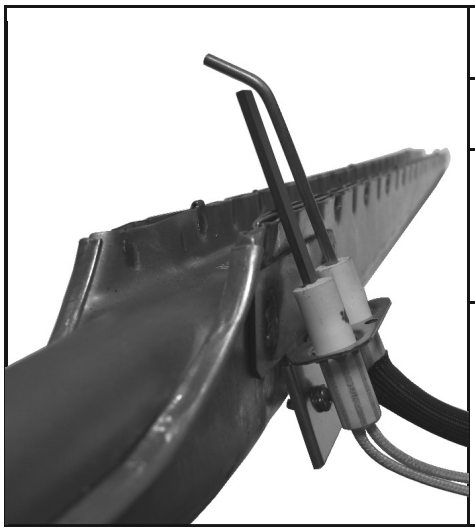


Figure 14

Table 3



HOT SURFACE IGNITER (HSI)	
Volts AC Nominal	80 VAC
Ohms Resistance	11.0 - 20.0 @ 77° F (25° C)
NOTICE FLAME ROD CROSSES PATH OF FLAME 0.1” to 0.25”.	

BLOWER PROVER SWITCH - SETTINGS

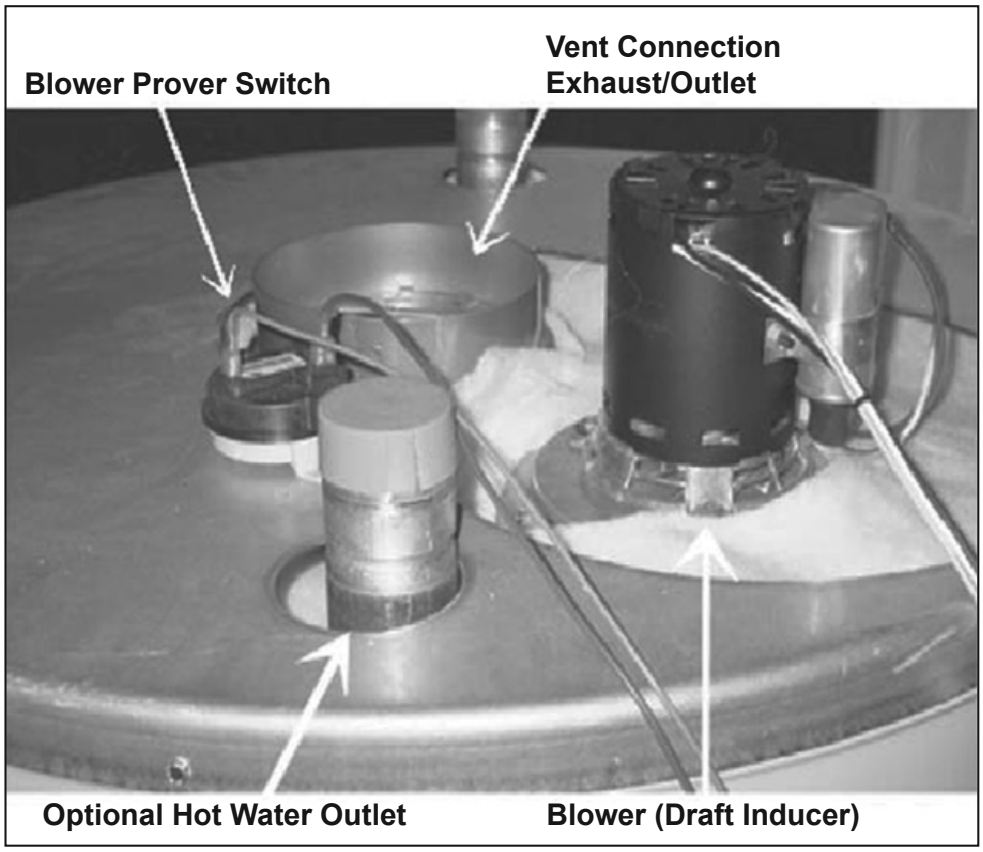


Figure 15

Table 4

BLOWER PROVER SWITCH TABLE	
BTR Model	Pressure Setting to Close Switch (Inches W.C.)
500/A	-2.85” ± 0.13”

NOTE: The Blower Prover Switch contacts are normally open and will close on a fall in pressure. This will be a negative pressure (i.e., a vacuum).

THERMOSTAT AND IGNITION CONTROL BOARD VIEW

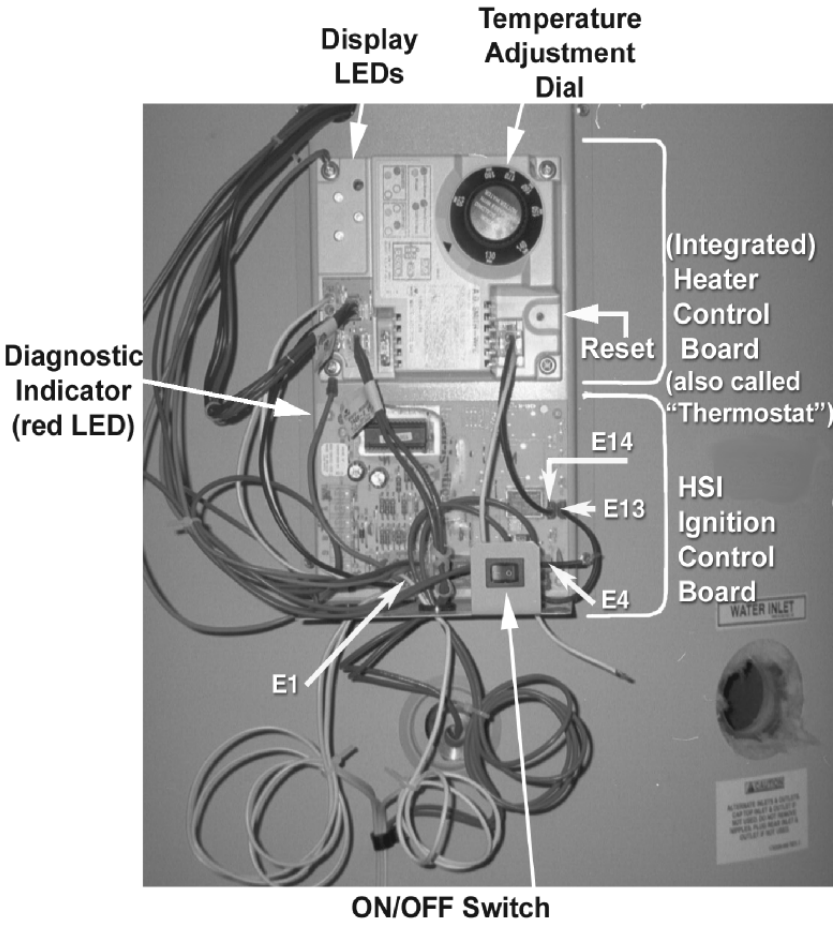


Figure 16

WHITE RODGERS INTEGRATED CONTROL - THERMOSTAT

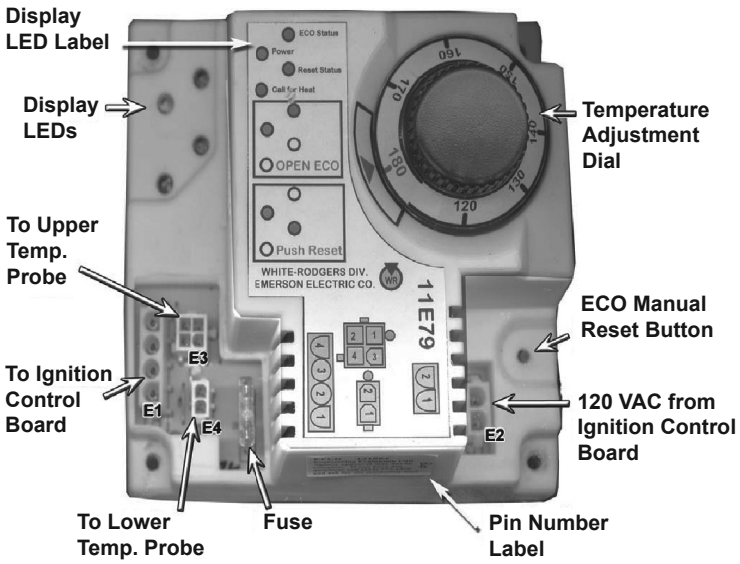


Figure 17

WHITE RODGERS IGNITION CONTROL BOARD

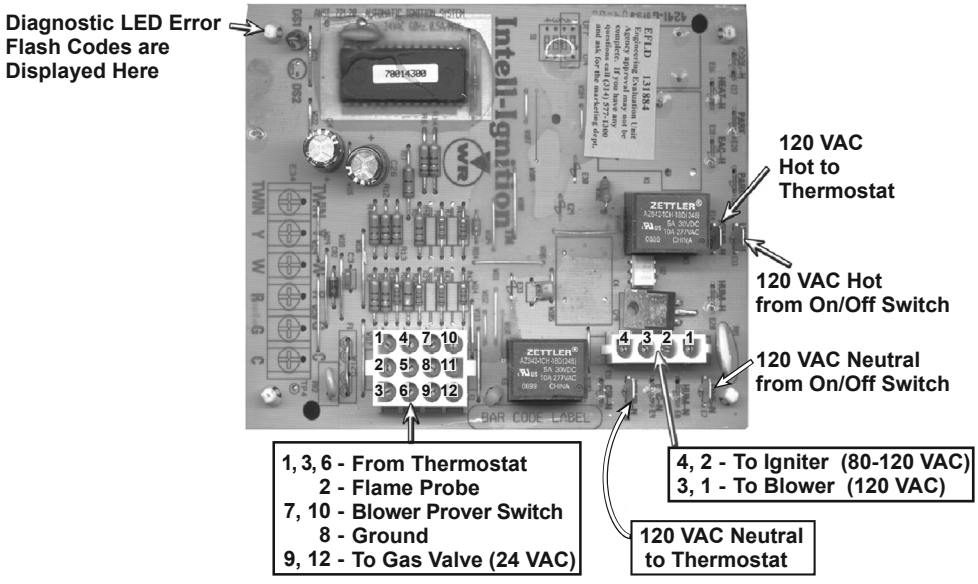

Diagnostic LED Error Flash Codes are Displayed Here
Intell-Ignition
120 VAC Hot to Thermostat
120 VAC Hot from On/Off Switch
120 VAC Neutral from On/Off Switch
1, 3, 6 - From Thermostat
2 - Flame Probe
7, 10 - Blower Prover Switch
8 - Ground
9, 12 - To Gas Valve (24 VAC)
4, 2 - To Igniter (80-120 VAC)
3, 1 - To Blower (120 VAC)
120 VAC Neutral to Thermostat
BAR CODE LABEL

Figure 18

Servicing should only be performed by a Qualified Service Agent

PRE-SERVICE CHECKLIST

Use the following checklist BEFORE you begin servicing the water heater.

1. Have you removed the cover from the controls?
    - Did you take notice of the status lights on the upper water heater control?
    - Did you take notice of the red LED in the upper left corner of the lower ignition control?
2. Did you note conditions of the room?
    - Where does the supply air come from?
    - Is the room clean?
    - What is stored with the heater?
    - How is the heater vented?
    - Are all water and gas shut-off valves open?
    - Are there room exhaust or air intake fans?
3. Did you note the condition of the heater?
    - Is the ON/OFF switch “On”?
    - What is the temperature of the stored water? (Test at T&P valve or nearby faucet.)
    - Is the thermal expansion tank installed?
4. Did you write down the complete model and serial number of the water heater? If so, what are they?_____
5. Does the heater have a good ground wire connection? If not, the blower (draft inducer) will typically come on for a short time (3-5 seconds), then go off, and the red LED will flash 8 times.

TROUBLESHOOTING

IGNITION CONTROL BOARD: ERROR CODES

The White Rodgers ignition control board will display a flashing error code with an LED light located on the upper left corner of the Ignition Control Board (Figure 18) when there is a problem. There is a distinctive pause between a series of on/ off flashes (1 to 8 flashes) when there is a problem. The following information describes the meaning of these error “flash” codes and what should be checked and/or repaired. The 5 flash error code is not used with this application.

NOTE: The Ignition Control Board varies the voltage to the Igniter to decrease wear. Lower voltage results in a longer life for the Igniter. For this reason, voltage to the Igniter may vary from 80 VAC to 120 VAC.

1 FLASH

System has locked out after 3 trials for ignition.

1 Check voltage (80-120 VAC) to igniter.

2 Check flame sense rod alignment.

3 Check igniter and flame sense rod wiring.

4 Check flame sense rod for corrosion; clean with steel wool.

5 Check igniter resistance. It should be 11 - 20 ohms.

6 Check ceramic insulator on igniter/flame sensor assembly for cracks. Replace if damaged.

7 Check manifold gas pressure.

8 Check all molex plug connections; on integrated control, ignition control board, and between the various components. Check the pin-to-pin contact between plugs; gently wiggle suspected plug connections during operation.

2 FLASHES

Blower Prover Switch circuit was closed during self-diagnostic check at the beginning of the heat cycle. Contacts should have opened at the end of last heat cycle. Blower (Draft Inducer) will not start; call for heat “Status” LED will be illuminated on integrated control.

1 Test continuity of blower prover switch; it should be open in “normal state” (blower not running - wires removed)

2 Replace blower prover switch if continuity is present between terminals in normal state.

3 Check blower prover switch wiring, making sure that there are no jumpers on blower prover switch.

3 FLASHES

Blower prover (air pressure) switch failed to close its normally open contacts after blower (draft inducer) was energized. Blower will run indefinitely, waiting for the blower prover switch circuit to close.

1 Check air pressure reading at blower prover switch sensing port on blower fan housing with manometer (digital preferred); blower must develop at least -2.85" W.C. (negative pressure) before blower prover switch contacts will close.

2 Replace blower prover switch if pressure reading at the sensing port does drop to at least - 2.85" W.C. and contacts remain open.

3 If pressure reading taken does not drop to at least - 2.85" W.C., check vent system for obstruction, debris, and excessive elbows. Ensure vent system complies with manufacturer's and NFGC venting requirements for fan assisted Category I appliances.

4 Ensure there is neither a negative or positive air pressure in the equipment room (open doors to outdoor atmosphere). This can cause the blower prover switch to malfunction. Alleviate air pressure imbalance between the equipment room and the outside atmosphere.

5 Check the condition of the blower wheel in the blower; clean or replace as necessary.

4 FLASHES

ECO cutout (Energy Cut Off). Tank temperature has risen above 203°F and caused lockout. ECO status LED on integrated control will also be illuminated. See Figure 17.

1 Determine if tank temperature is excessive and, if so, the possible cause (i.e., temperature control failing to cut out at set-point).

2 Cool tank to below 120°F to reset. ECO reset status LED will illuminate on the integrated control when the control can be reset. Push reset button on integrated control. See Figure 17.

3 Check continuity/resistance of temperature probes; clean off calcium build up.

6 FLASHES

Reversed polarity in power supply.

1 Interchange "hot" and "neutral" wire connections to the water heater.

7 FLASHES

Flame sensing is marginal; flame sense signal is below 2.0 micro-amps. Water heater will continue to fire with flame sensing current over 0.1 micro-amp; below this, the control will close the gas valve and ignition failure will occur.

1 Check flame sense rod alignment.

2 Clean flame sense rod with steel wool.

3 Check ceramic insulator on igniter/flame sensor for cracks. Replace if damaged.

4 Check molex plug connector between igniter/flame sensor assembly and control board; Also check flame sense (12 pin) plug connection at control board.

8 FLASHES

Igniter not sensed and/or water heater not grounded.

1 Test igniter resistance. It should should be 11 - 20 ohms. Replace igniter if open continuity.

2 Ensure that the water heater is grounded. Check all ground wires on heater and controls.

3 Check molex plug connector between igniter/flame sensor assembly and control board. Also check igniter (4 pin) plug connection at control board.

CONTINUOUS FLASH

Flame sensed out of sequence; continuous flame sensed for more than 5 seconds without gas valve being energized.

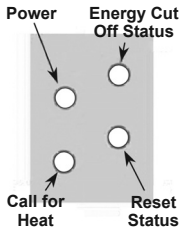
1 Ensure that the gas valve is not failing to close at the end of the heating cycle.

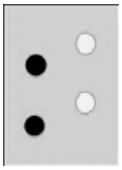
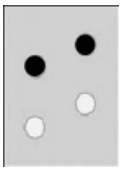
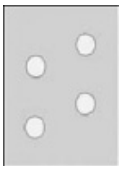
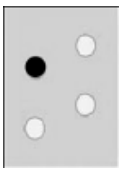
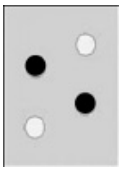
CONTINUOUS ON

Internal control board failure.

1 Replace ignition control board.

INTEGRATED HEATER CONTROL: DISPLAY LIGHTS



LED STATUS	INDICATION	ACTION
	Calling for heat	Normal status. No action required.
	The ECO (Energy Cut-Off) has opened.	• Check for excessively hot water (203° F or higher). • Correct the problem
	No power	Check the breaker.
	Tank is at a set temperature ± 2° F.	No action required.
	Tank has cooled below 120° F. Preceded by “ECO Open” indication.	• Push the manual reset button. Refer to Figure 17. • Troubleshoot for the reason that the ECO opened.

TEST 1: 120 VAC TO HEATER CHECK

Conditions:

- No Green Display “Power” LED on.
- Plugs are in receptacles.
- Supply power breaker is not open.
- On/Off heater switch is on.

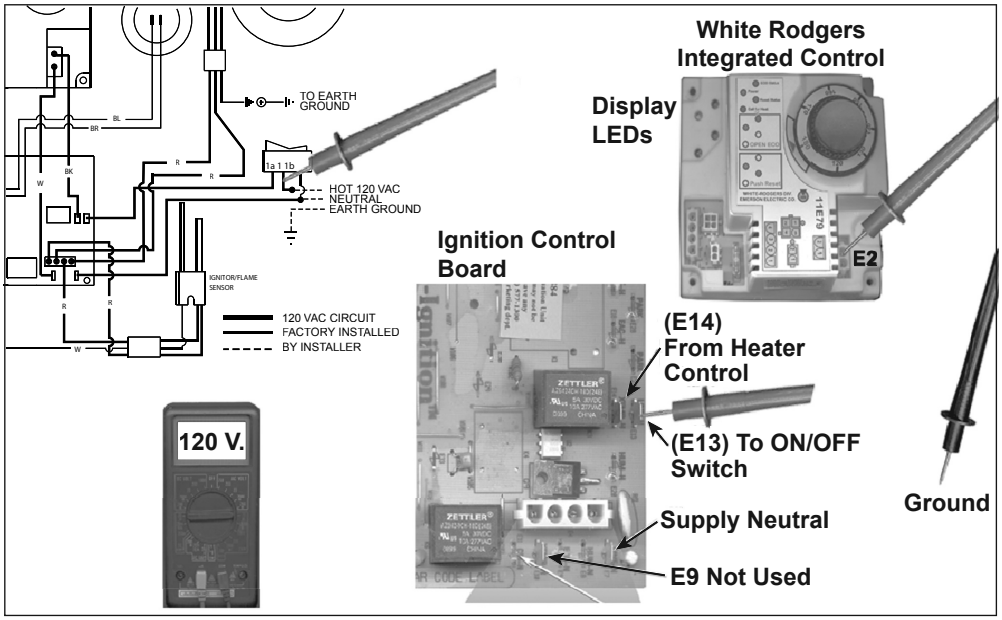


Figure 19

TEST 1	**120 V. AC check to water heater ON/OFF switch** **Check for 115-125 VAC black wire to ground\ 115 VAC check to E13 Terminal and 2B receptacle.**
IF.....	**then.....**
voltage is not present from on/off switch center black wire to ground	• check conditions above. • check wiring from switch to break box.
Power is present from center on/off terminal	check power from on/off switch to ignition board terminal E13
Voltage is not present at E13 to ground	• check wiring from on/off. Left-outside terminal to E13. • Replace on/off switch.
Power is present at E13	check power from E14 to water heater control E2 receptacle
Voltage is not present from water heater control receptacle E2 black to ground	• check wiring from ignition control board E14 to water heater control receptacle E2. • Replace ignition control board.
Power is present at E2.	green LED should be on.

TEST 2: POLARITY CHECK

Conditions:

- No hot water
- Green “Power” LED is on.
- Tank is more than 5° F below temperature dial setting.
- Red ignition control board diagnostic LED is flashing 6 times between pauses.
- Red, diagnostic “Call for Heat” LED-OFF.

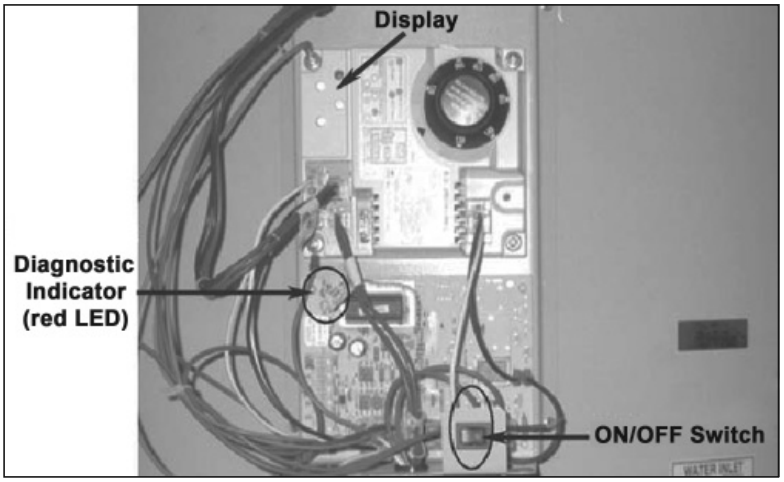


Figure 20

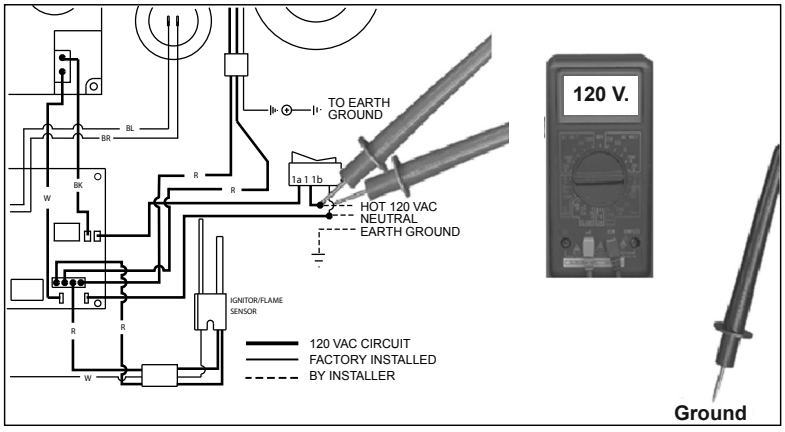


Figure 21

TEST 2	Polarity Check
	Check from on/off switch center and white wire terminals to ground
IF.....	**then.....**
115-125 VAC is not present	see Test 1.
Voltage is present white (right terminal) to ground but not black (center terminal) to ground	reverse supply wire connections. Polarity is reversed.

TEST 3: CONTINUITY CHECK OF HIGH LIMIT (ECO)

Conditions:

- Power On – No Hot Water
- Red, heater control “Call for Heat” LED – on
- Red ignition control board diagnostic LED – 4 Flashes
- Note LED Flash Code before resetting water heater control.
- See *Ignition Control Board: Error Codes.*
- Turn Power OFF.

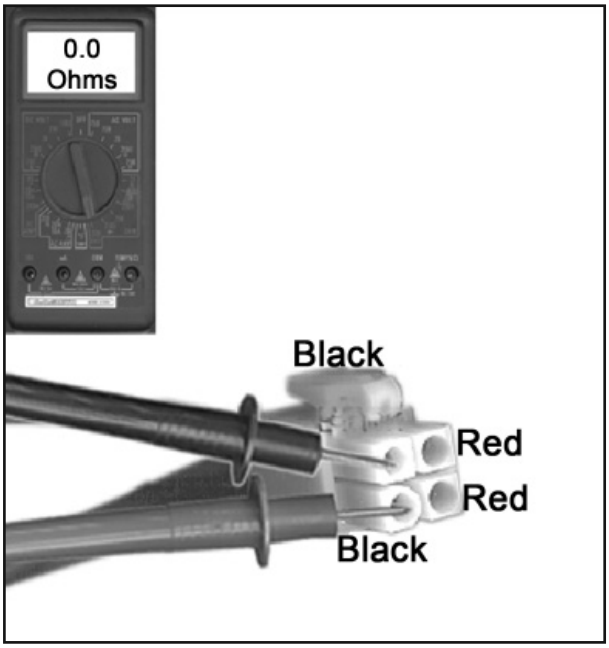


Figure 22

TEST 3	**Continuity check of ECO (energy cut-off, high limit)**
	Black to Black wires of upper probe. Power is off.
IF.....	**Then.....**
continuity is indicated (ZERO “0.0” Resistance)	opens at 203° F; closes at 193° F. If water is below 193° F, continuity is correct.
continuity is not present (meter reads “0.L”)	replace ECO sensor if water temperature is below 193° F.
water is less than 120° F	• reset status LED should be on. • replace heater control if control will not manually reset.

TEST 4: UPPER TEMPERATURE PROBE CONTINUITY CHECK

Conditions:

- Power On - Water below temperature set point.
- Red, water heater control “Reset Status” LED-OFF
- “Call For Heat” LED off.

TEST 4	Upper Temperature probe continuity check Red wire to red wire - Turn supply power “Off” for this test
IF.....	**then.....**
Test indicates no continuity	replace probe.
Continuity is indicated	Probe should be okay. (Also verify Ohms resistance for water temperature. Reading will be approximate.)

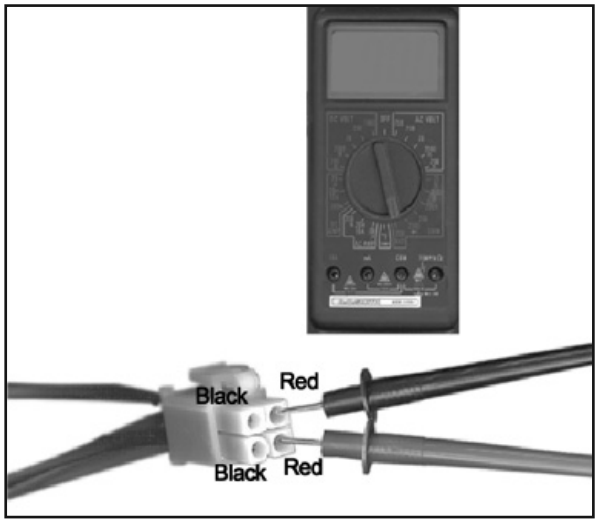


Figure 23

Table 4

OHMS RESISTANCE TABLE	
° F	**Ohms**
70°	**11,884**
120°	**3,759**
140°	**2,488**
180°	**1,169**

TEST 5: CALLING FOR HEAT - NO BLOWER OPERATION

Conditions:

- Power on
- Plugs in Receptacles
- Red " Call for Heat" LED - ON
- Blower (Draft Inducer) off

Note flash code on ignition control board diagnostic LED.

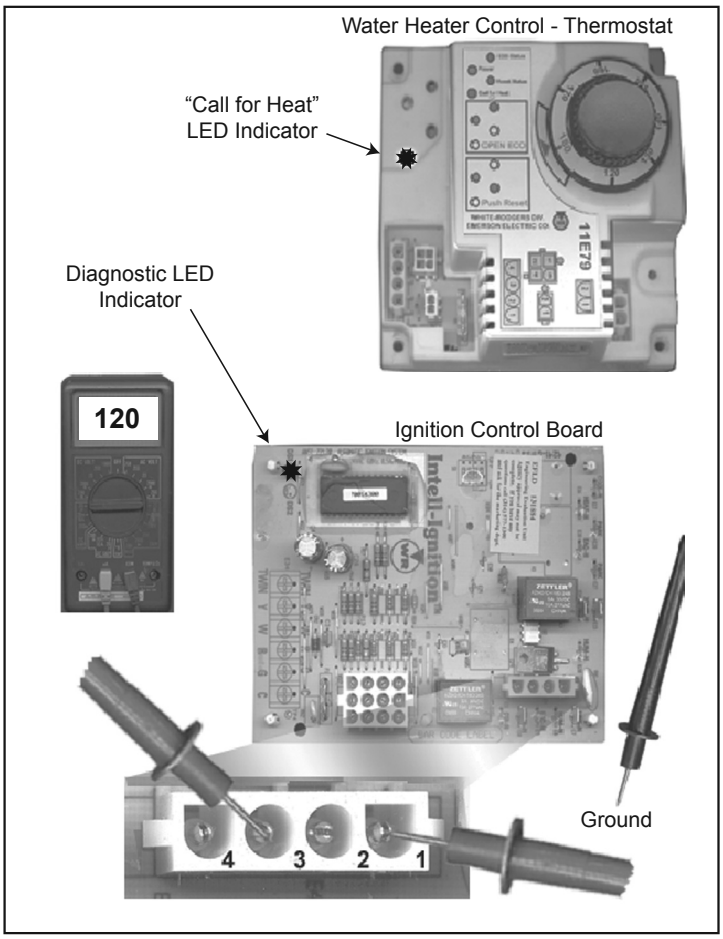


Figure 24

TEST 5	
IF.....	**then.....**
Pin 1 to ground check has no voltage	• reset control by interrupting power. Note possible reasons for this from flashing LED code. • replace ignition board.
Pin 1 to ground has voltage	Proceed
Pin 3 to ground has no voltage	• check wiring harness and plugs. • replace blower.

TEST 6: BLOWER ON, NO IGNITION

Conditions:

- Power on
- Plugs in receptacles
- Blower (Draft Inducer) operating
- No power to Hot Surface Igniter (HSI). Note LED flash code.

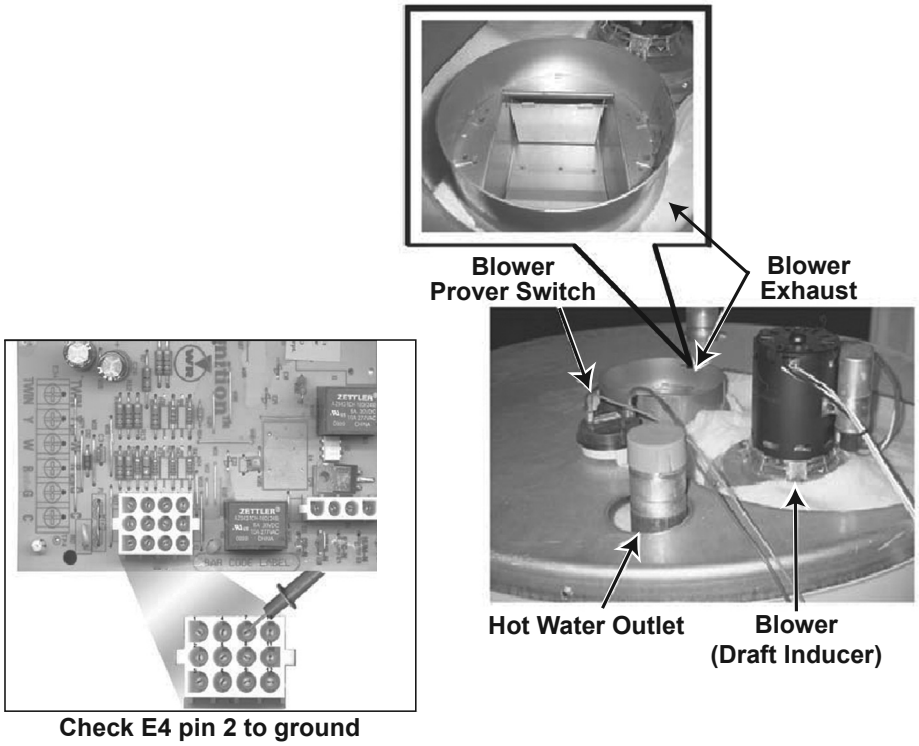


Figure 25

TEST 6	24 VAC Check of Blower Prover Switch Circuit
IF.....	**then.....**
ignition board receptacles E1, Pin 7 to ground shows no voltage	replace Ignition board.
E1, Pin 7 has 24 Volt to ground	check wire connection to and from blower (draft inducer).
voltage check of each blower switch terminal to ground shows voltage to only 1 terminal	• switch is open. Check for proper draft (should also see LED 3 flash code). • check for blocked exhaust. • check that blower outlet exhaust damper is open. • replace blower prover switch.

TEST 7: BLOWER ON, BLOWER PROVER SWITCH CLOSED, NO IGNITER OPERATION

Conditions:

- Power on, but no power to igniter
- Plugs in receptacles
- Blower (Draft Inducer) on
- 24V at ignition board E1, Pin 10

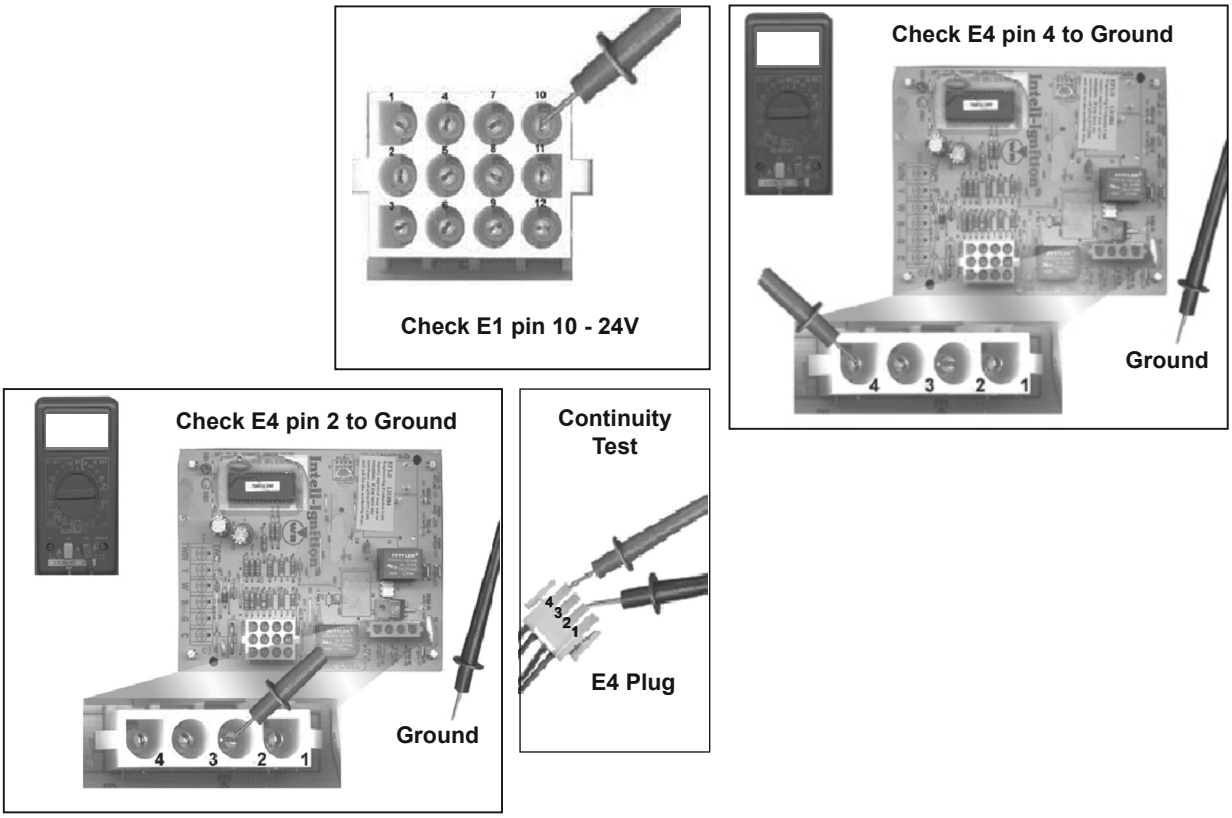


Figure 26

TEST 7	Voltage check and continuity check of hot surface igniter circuit Continuity check - Power off- Plug removed from E4 receptacles. Nominal 80 VAC check - Plug in E4- Power on.
IF.....	**then.....**
Continuity is not indicated between E4 plug pin 2 to 4.	• check wiring and connection from E4 plug to HSI receiving plug. • replace HSI Assembly.
Continuity is present	Resistance should be between 11 and 20 Ohms at a temperature of 77°F.
Voltage is not present between E4, Pin 2 to ground	Replace ignition board.
Voltage is present	Continue
Voltage is not present between E4, Pin 4 to ground	• check wiring and plug connections to hot surface igniter (HSI). • replace HSI if needed.
Voltage is present	Note ignition board flash code LED. Hot surface igniter (HSI) should work.

TEST 8: IGNITER HEATS, NO MAIN BURNER

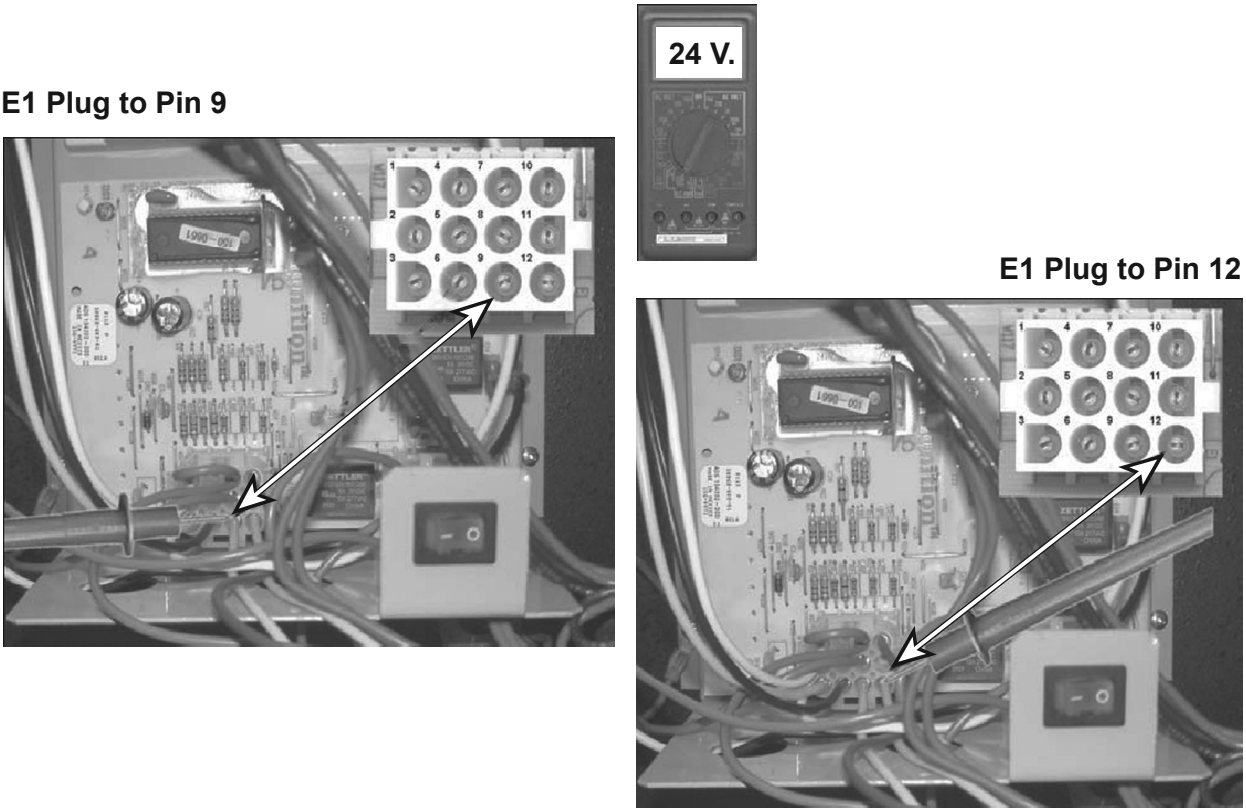


Figure 27

TEST 8	IGNITER HEATS.....NO MAIN BURNER
IF.....	**then.....**
short heat up time of igniter	check control box grounding.
Normal warm up (Approximately 20 seconds) - No ignition	check for 24V from E1, Pin 12 to ground during 4 second trial. If Yes, continue. If No, replace Ignition Board
No voltage present E4, Pin 12 to ground	replace ignition board.
24 Volt was present from E1, Pin 12 to ground, but no main burner	• check that air has been purged from gas circuit. • check that wiring and connections to gas valve and E1, Pin 9 are correct. • check for 24 VAC at E1, Pin 9 to ground during 4 second trial for ignition.

TEST 9: IGNITER HEATS, NO MAIN BURNER

Conditions:

- Test 8 completed
- Turn off power
- Disconnect wires from gas valve

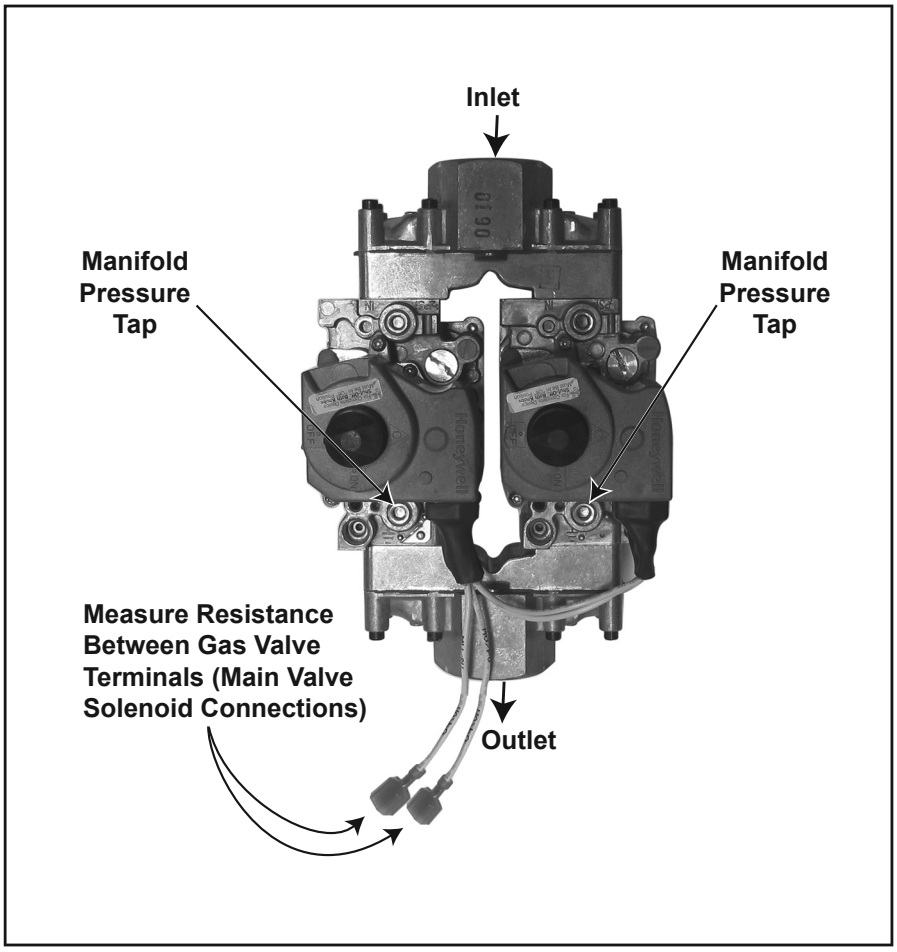


Figure 28

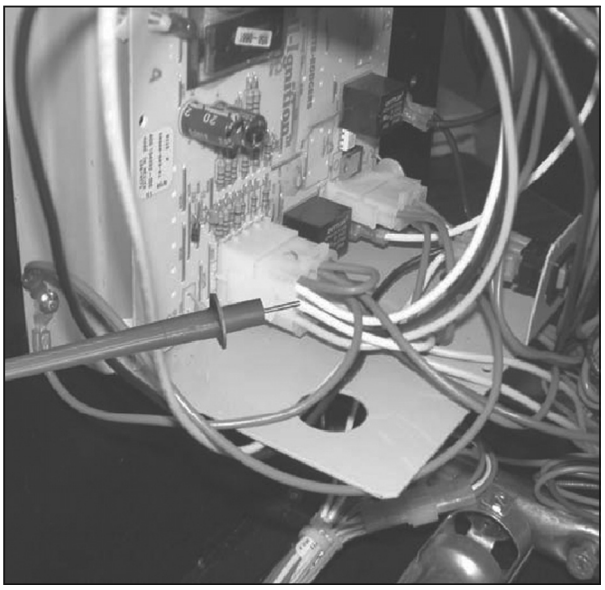
TEST 9	IGNITER HEATS – NO MAIN BURNER
IF.....	**then.....**
Meter reads 0 or 1	• Check meter scale setting; verify that it is set to read between 550 and 650 Ohms. • replace the gas valve
Meter indicates pilot and main coil have continuity	valve should be okay. However, if there is still no gas to the main burner, the coil may be stuck. Replace the gas valve.

TEST 10: MAIN BURNER IGNITION FOR LESS THAN FIVE SECONDS

Conditions:

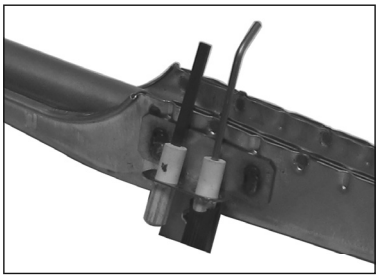
- Power On; plug connected
- Main Burner ignites for approximately five seconds, then goes out.
- Tests 8 and 9 completed

Note the flash code on the ignition board LED.



E1, Pin 2 (From Flame Proving Rod)

Hot Surface Igniter (HSI)



HSI Mounted on Main Burner

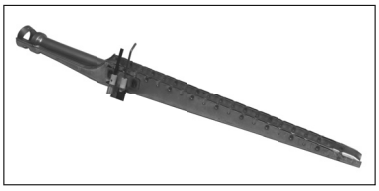


Figure 29

TEST 10	MAIN BURNER IGNITION FOR LESS THAN FIVE SECONDS
IF.....	**then.....**
no extended main burner ignition	• check wiring and plug connections of hot surface igniter (HSI) assembly plug and ignition board receptacles E1, Pin 2. • verify that HSI assembly is not cracked or dirty. • verify that flame prover will be in main flame. • replace HSI assembly.
still no extended main burner ignition	replace ignition control board.

TEST 11: WATER HEATER SHUTTING OFF BELOW SETTING

Conditions:

- Main burner ignited
- Stored water is below temperature setting more than 5° F (Tank Average).
- Power off
- Plug disconnected from heater control board receptacle E3 and E4

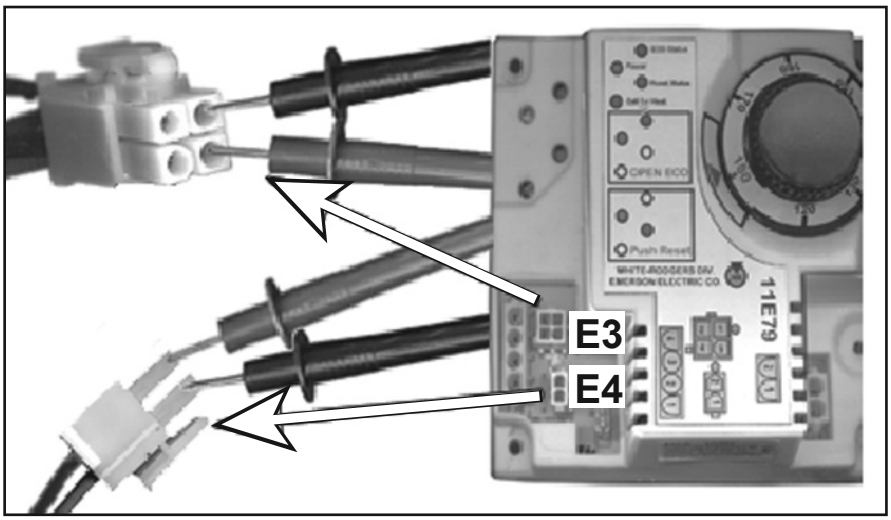


Figure 30

TEST 11	WATER HEATER SHUTTING OFF BELOW SETTING (Water Temperature Circuit Check - Continuity)
IF.....	**then.....**
Continuity check pin to pin of lower temperature probe shows 1 or 0 (E4)	See Test 4. • check wiring and plug connections to heater control board receptacle E4. • replace lower temperature probe.
Continuity check red wire pin to red wire pin on upper temperature sensor shows 1 or 0 (E3)	See Test 4. • check wiring and plug connections to heater control board receptacle. • replace upper temperature probe.
All above checks are okay	• Check wiring and plug connections to heater control board receptacle. • Replace upper temperature probe.

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